Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

them. This want of *precise* coincidence between the superimposed or coinciding direct and reflex images is associated with the idea of solidity, and is reproduced in stereoscopic pictures.

Four hundred and seventy-seventh meeting.

March 6, 1860. — Special Meeting.

The President in the chair.

Mr. E. S. Ritchie exhibited a series of experiments in Magneto-electricity. He gave a brief account of the several steps which had led to the invention of the Ruhmkorff apparatus, and spoke of the effect of the condenser first introduced by Fizeau, which at once converted the instrument into a powerful source of tensional electricity. After alluding to the increased energy which he had been able, by certain modifications, to impart to the apparatus, he proceeded to show its effects by a variety of experiments, exhibiting the spark as transmitted through the air, the charging of the Leyden jar, the illumination of the Torricellian vacuum and of various gases and vapors when greatly rarefied, and the influence of the poles of a powerful magnet on these luminous discharges.

In the course of these experiments he showed the effect of a current of air upon the form of the spark as first observed by Du Moncel; the brilliant explosive spark of the Leyden jar in the outer helix, discovered by Grove; the common and stratified discharges through a tall vacuum-tube containing vapor of turpentine; the same through a tube of uranium glass displaying the characteristic fluorescence; the phenomena of Gassiot's cascade, with the purplish fluorescence of the outer glass and the green of the uranium goblet within; the various-colored light and its stratifications in the rarefied gases of Geissler's Tubes; the strong fluorescence of solution of sulphate of quinine when illuminated by some of these lights; the spectra furnished by others; the attraction and repulsion of a magnetic pole on the luminous strata;

and De la Rive's experiment of the revolution of the luminous streams *in vacuo* around the poles of a magnet.

Professor W. B. Rogers called attention to the nature and extent of the improvements which Mr. Ritchie had made in the Ruhmkorff apparatus.

In the construction used by Ruhmkorff and others, the outer helix is wound in strata or courses parallel to the axis of the coil, separated from one another by layers of insulating material. This brings into proximity parts of the circuit which are really remote from each other as measured along the course of the wire, and by the unequal tension of the electric wave at these points tends to produce discharges within the helix or around its ends.

In instruments having a moderate length of wire, the insulation is sufficient to prevent such discharges; but when the coil is made up of a great number of these superimposed courses, the enormous difference of tension between the outer and inner parts of the helix overcomes the resistance of the insulating material, and either destroys the action of the instrument by an internal discharge, or wastes a great part of its energy by frequent sparks around the extremities. If to obviate these evils we increase the thickness of the insulating sheets, we augment in the same proportion the distance through which the primary coil exerts its inducing power upon the outer helix, and thereby in a still higher ratio impair the energy of the induced current. Thus constructed, therefore, it would appear that the power of the instrument is unavoidably restricted within moderate limits.

It is but just to state, that Professor Poggendorff was the first to point out this defect in the Ruhmkorff apparatus, and to attempt its remedy by dividing the helix into short sections. But he made no further application of the principle than to construct instruments with eight short coils placed end to end, which, although somewhat more effective, were still, as he confessed, too much exposed to "the disturbing effects of internal sparks" to present a very decided advantage.

Mr. Ritchie, abandoning the attempt to improve the apparatus on the old construction, determined on *building up the helix from a series of thin strata or rings placed perpendicular to the axis.* By this arrangement the distance between the points of a stratum increasing with their difference of tension, *the resistance is augmented in proportion to the tendency to discharge*, and thus each stratum is effectually precluded from the production of sparks within itself. It only remains, therefore, to interpose a sufficient insulation between the successive strata to prevent discharges from one to the other, and the instrument becomes secure from the enfeebling or destructive losses incident to the old construction of the coil. Such was the theory of the improvement; and Mr. Ritchie soon devised a contrivance for winding the helix in planes perpendicular to the axis, carrying the wire alternately from the inner to the outer circumference, and from the outer to the inner, and at the same time securing perfect insulation within and between the strata.

The new construction proved eminently successful, conferring on the coil a tension much greater than had hitherto been attained. By further improvements in details, Mr. Ritchie has continued to add to its power, so that now, while the best European coil cannot be relied on for a spark of more than five inches, Mr. Ritchie's first-class instrument projects its luminous flash across an interval of fifteen inches, and exhibits other electrical phenomena on a scale of corresponding magnitude and splendor.

Among the subordinate improvements devised by Mr. Ritchie is a new construction of the breakpiece, in which a spring, bearing the platinum plate and pressing it firmly against the "anvil," secures a closer contact than by the ordinary arrangement. The separation is made by the blow from a spring-hammer worked by a small ratchet-wheel. In this way the *time* of contact is sufficiently prolonged to allow the iron core to be fully magnetized and the electricity to be developed throughout the wire, which, in a helix of thirty miles, must require an appreciable time. This advantage is of course lost in the automatic interruptor of De la Rive, where the armature is so instantly withdrawn as in a moment to break the current. In Mr. Ritchie's plan, moreover, the manipulation of the instrument is placed entirely under the control of the operator, so that by varying the intervals of interruption he can vary the length and character of the spark, and by proper adjustment obtain the greatest length of spark of which the apparatus is capable. To prevent the discharge taking place through the primary coil or its core, Mr. Ritchie, as a substitute for the insulating tube, interposes a bell-glass closed at the top, and with its lower edge turned outward in a flange. He makes the secondary helix in one or several portions, each wound upon a gutta-percha bobbin, so that one or all can be lifted from around the glass bell, which in like manner can be lifted from the primary. The secondary helix of his first-class apparatus contains about thirty miles of wire; that of the apparatus giving a ten-inch spark contains eighteen miles.

Another novel feature in the construction of the instrument, found by Mr. Ritchie materially to augment its power, is *the extension of the primary helix and its core to some distance beyond the ends of the secondary.* In the smaller instruments he adopts the proportion of two to one, and in the larger, of about one and a half to one.

Mr. Ritchie, moreover, separates the condenser into several portions, each connected with a screw upon the base of the instrument, enabling the operator to vary at will the amount of condensing surface, or to dispense with it entirely, and by these changes giving rise to many remarkable varieties in the phenomena.

In addition to these peculiarities contributing to the superiority of the instrument, it should be mentioned that Mr. Ritchie uses a much finer wire in the secondary coil, and a much coarser in the primary, than have heretofore been employed. It should not be omitted in the comparison, that while the European apparatus requires for the full development of its action a large intensity-battery, his coil is excited by *a few cells* to the highest display of its power.

Professor Rogers called attention to the peculiar characters of the spark of the induction coil when transmitted through the air at different distances between the terminals. When the distance is short, as, for example, one or two inches in the instrument exhibited to the Academy, the spark has the peculiar twofold character first noticed by Du Moncel, and since minutely studied by him and Perrot and others; that is to say, it is formed of a slender, brilliant thread, enveloped by a much wider and less luminous space of a somewhat ruddy, flame-like aspect. As the striking distance is increased, this surrounding glow becomes less conspicuous, in comparison with the brilliant thread of light, and at last, when the interval has been sufficiently extended, it nearly or wholly disappears, leaving the spark to consist of a slender, jagged, brilliant line.

These two parts of the luminous discharge, which we may call the *flame-spark* and the *thread-spark*, present remarkable differences of character, indicating very unlike states of tension in the currents or portions of current to which they are severally due. Thus the flame-spark possesses great heating power, while the thread-spark is almost destitute of it; hence the facility with which paper and other combustibles are ignited, when placed in a short spark, and the entire failure of this effect when they are made to intercept a long one.

The fact of the spreading out of the flame-spark under the impulse of a transverse blast of air, while the luminous thread experiences no change, would naturally suggest the comparatively *slow motion* of the former; and accordingly Robinson of Armagh, by applying the test of the revolving mirror, has proved that the velocity of the flame-spark is very much less than that of the thread-spark.

Recently, Du Moncel and Perrot have made numerous experiments on the two kinds of sparks, and the latter, availing himself of the effect of a current of air on the flame-spark, has succeeded in separating the two so completely as to be able to mark more certainly their respective peculiarities. These observations have shown that the current belonging to the flame-spark is endowed with decided magnetic and chemical, as well as heating powers, while that of the other is as little efficient in these respects as that of common frictional electricity. In view of these various characteristics, we are entitled to conclude that the flame-spark is due to a current of low tension, like that of an ordinary voltaic arrangement, and the thread-spark to one of high tension, comparable to the discharge of an electrical machine. Whether these currents are to be regarded as simultaneous or alternating in their transit through the coil, remains to be determined.

The very different character of the discharge through the air when the terminal wires are near each other, and when far apart, is no doubt dependent on the different degrees of resistance which the interposed air presents to the passage of the current. When the terminals are at a short distance asunder, the induced current, having comparatively small resistance to overcome, begins to pass across before its tension has been much exalted, and thus discharges itself continuously during a short time and at a low tension. But when the terminals are widely separated, the current is at first unable to make the transit, and has to accumulate a very high tension at the terminals in order to overcome the greatly increased resistance; and when at length it forces a passage, it does so, as might be expected, with a correspondingly greater velocity, and completes the discharge more nearly in an instant. Thus, in the former case it shows itself chiefly as the flame-spark, in the latter, as the thread-spark.

The remarkable difference of tension according to the distance between the terminals, or, in other words, to the length of the spark, is no doubt one, and perhaps the only, reason for the effects observed in attempting to charge a Leyden jar by the inductive machine. When we connect the outer coating of the jar with one of the terminals, and bring the knob quite near the other, we see the broad flame-sparks passing in quick succession; but only a feeble charge is imparted, however we may prolong the experiment. When, however, the knob is held at a much greater distance from the terminal, a few of the long thread-sparks are sufficient to charge the surface strongly.

The beautiful phenomena of *electrical light in rarefied gases,* as exhibited in the electrical egg and Gassiot's and Geissler's vacuum-tubes, afford many interesting subjects of inquiry. As the color of the light is dependent on the specific nature of the gas, and as this is reduced to an extreme degree of rarefaction, we have a means in some cases of identifying such substances when their quantity is so minute as to defy all other means of detection. With tubes of slender bore, affording, as has been seen, a light of great intensity, we may obtain a brilliant prismatic spectrum, which, as Plücker has shown, is marked in each case by some characteristic peculiarity; and with the same arrangement we are able to trace the chemical changes which the enclosed gas or vapor undergoes while subjected to the electrical action.

Perhaps the most important observations in this connection are those recently made by Gassiot, whose ingenious application of the absorbent power of potassa has enabled him to approximate more nearly to an absolute vacuum than any previous experimenter. In a tube thus prepared, he has found that the gas may be so excessively rarefied as to be unable to transmit the current, at this stage ceasing to be luminous. We may therefore conclude that the old notion of a vacuum being a good conductor, which was founded on the electric illumination of the Torricellian space, is entirely erroneous, and that in all cases conduction is dependent on the presence of some form of ponderable matter.

Adverting to the new evidences which these and other recent experiments afforded of the electrical character of the *Aurora,* Professor Rogers called attention to the action of a magnet on the electric light, and more particularly to its power of arranging the illumination in meridional bands, and impressing upon them a movement of rotation, as exhibited in De la Rive's experiment; and mentioned the ingenious suggestion of Grove, that the height of the aurora above the earth's surface might perhaps be inferred from a knowledge of the degree of rarefaction at which like luminous effects were obtained in the vacuum-tubes.

In connection with the *fluorescent* influence of the light of some of the tubes, he mentioned the fact, that, during the brilliant auroral displays of August and September last, he found that a solution of sulphate of quinine showed its characteristic fluorescence quite distinctly when exposed during the height of the illumination.

In regard to the *stratified* character of the discharge, as exhibited so strikingly in some of the experiments, Professor Rogers remarked that this phenomenon, supposed hitherto to belong exclusively to the current of the induction coil, has recently been produced by Gassiot with machine electricity, and with the *continuous current* of a voltaic battery of very high tension. As to the conditions in which the stratification originates, physicists are as yet undecided. The gradation of the phenomenon in different stages of exhaustion does not seem to have been sufficiently considered, and would naturally suggest an hypothesis which may not be unworthy of attention.

When the experiment is made, while the process of exhaustion is going on, the following stages in the effect may be observed: —

1. While the rarefaction is yet very incomplete, the tube is dark, and no current transmitted.

2. When the exhaustion has advanced to a certain point, the current passes and the tube becomes filled with a colored electrical light, which as yet shows no appearance of stratification.

3. At a still higher stage of rarefaction, the column of light begins to exhibit a multitude of extremely thin closely contiguous strata, discernible with a magnifier before they become apparent to the naked eye.

4. As the rarefaction is pushed still farther, these strata become larger and more distinct, with wider intervals of comparatively obscure space between them.

5. Approaching the extreme limit of exhaustion, a few waves occupy the whole extent of the tube, and finally the light ceases as the current fails to be transmitted.

In view of these facts, may we not believe that, *in every case where* *the current passes, it is accompanied by stratification,* — in other words, by a molecular vibration, or the formation of waves rapidly propagated through the gas or vapor, — and that the increasing rarefaction allows a greater amplitude for the oscillations, and thus gives rise to longer and longer waves?

In referring to the *actinism* of the electric light, Professor Rogers described some experiments which, with the aid of Mr. Ritchie and the distinguished photograper, Mr. Black, he had lately made on the photographic energy of the different colored lights of the Geissler vacuum-tubes. These, he stated, were but preliminary to more extensive observations on the subject, which he hoped, through the same kind aid, to be able to report on hereafter. The most striking results thus far noted are the following: —

1. The faint, bluish light surrounding the negative wire is superior in actinic power to the more brilliant glow of the opposite bulb of the apparatus.

2. The actinism of the rays emerging from the tube is greatly increased by passing them through a solution of sulphate of quinine, so as to impress them with the *fluorescent* character.

3. The time required for a distinct photographic impression was greatly less than by the ordinary daylight. In the case of a narrow tube transmitting a bright purplish flash, a strong picture was made on the collodion plate in less than half a second. This corresponded to one turn of the ratchet-wheel, or twelve successive flashes of light passed through the tube. Allowing each flash to occupy tenfold the time of an electric spark, as measured by Wheatstone, we should have an aggregate of time during which the twelve flashes acted of less than $\frac{1}{100000}$th of a second.

A number of positive impressions on paper, printed from the original collodion surfaces, were exhibited as results of these preliminary experiments.

On motion of Dr. C. T. Jackson, the thanks of the Academy were voted to Mr. Ritchie for his interesting and brilliant exhibition.